US energy security and policy options for the 1990s

George C. Georgiou

This paper makes the case that the current complacency regarding the world oil market and the weakened position of OPEC in the aftermath of the Gulf War is premature as well as shortsighted. It proceeds to argue that in the foreseeable future, a core group of OPEC countries, all located in the Persian Gulf, that hold two-thirds of the world's proved reserves of oil, may regain control of the world oil market and thereby develop into a more dominant cartel than OPEC was in the 1970s. Given the pattern of production and consumption of energy in the 1980s and those projected for the 1990s, oil will remain the most critical energy source into the 21st century both for the USA and the world. Progress in terms of improved energy efficiency in the form of conservation, and fossil fuel substitution in the form of renewables, is not expected to increase the energy security of the USA by 2000 given present circumstances and the absence of a comprehensive national energy policy. On the contrary, US energy security will be lessened and the USA will be increasingly vulnerable to external energy shocks.

Keywords: Energy security; OPEC; Policy options

Iraq's invasion of Kuwait on 2 August 1990, gave Iraq temporary control of 20.9% of total world oil reserves and 28.4% of OPEC reserves. This would have made Iraq the largest player in the world oil market displacing Saudi Arabia with 18.5% and 25.1% of proved world and OPEC reserves respectively.[1] The international response to Iraq's invasion of Kuwait was to impose an economic embargo on both Iraq and Kuwait, which resulted in a doubling of the world price of oil from its average of $16.40/bbl in July, 1990,[2] to an average of $31–34/bbl in the 3rd quarter of 1990.[3] Before the embargo, Iraq and Kuwait were producing approximately 4.3 million barrels per day (mbpd) or 9% of the non-Communist world output.[4]

By the end of the year increased output by Saudi Arabia and other major oil exporting countries within OPEC were more than able to make up for the combined lost output of Iraq and Kuwait. Prices continued, however, to exceed the pre-invasion level by an average of $10/bbl. Following the military defeat of Iraq by the coalition forces, crude oil prices fell quickly to their pre-invasion level, averaging $17.50/bbl in May 1991.[5] Iraqi and Kuwaiti oil output continues to be negligible.

The key question, then, is to what extent has the recent Persian Gulf crisis had a permanent impact on the world oil situation, and more specifically to what extent has this had a permanent impact on the future of OPEC? Furthermore, what does this imply for US and world energy security?

This paper will make the case that the current complacency regarding the world oil market and the weakened position of OPEC is premature as well as shortsighted. It then proceeds to argue that in the foreseeable future, a core group of OPEC countries, all located in the Persian Gulf, that hold two-thirds of the world's proved reserves of oil, may regain control of the world oil market and thereby develop into a more dominant cartel than OPEC was in the 1970s. Given the pattern of production and consumption of energy in the 1980s and those projected for the 1990s, oil will remain the most critical energy source in the year 2000 both for the USA and the world. Progress in terms of improved energy

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efficiency in the form of conservation, and fossil fuel substitution in the form of renewables is not expected to increase the energy security of the USA by 2000 given present circumstances and the absence of a comprehensive national energy policy. On the contrary, US energy security will be lessened and increasingly vulnerable to external energy shocks.

The resurgence of a new OPEC?

Paradoxically, the changes in the structure of the oil market that have weakened OPEC's market control in the 1980s, may also in the future help bring OPEC back into a position of greater power.[6] It is important to remember that OPEC's inability to control the oil market during the 1980s was largely the result of the fall in world demand for oil between 1979 and 1985, and the increase in non-OPEC production resulting in substantial unused production capacity among the oil exporting countries estimated at about 10 mbpd[7] – factors that are beyond OPEC's control and are not permanent changes in the world oil equation. But oil demand and supply could shift in the 1990s just as dramatically as they did in the 1980s, in fact these shifts may already have begun, thus putting OPEC in a position at least as strong as the one it occupied in the 1970s. To ignore these trends is both shortsighted and unwise.

One obvious factor to consider is world demand for oil which has grown at an average annual rate of 2.35% a year since 1985,[8] reversing the negative trend of the 1979–85 period. World demand for oil declined from a peak of 64.1 mbpd in 1979 to 58.6 mbpd in 1985, a decline of about 8.5%. Since then world demand has increased steadily reaching and matching the 1979 peak demand of 64.1 mbpd in 1989, a total increase of about 10%. This demand is expected to grow at an annual rate of 1.5–2.0% from 1990 to 2000.[9]

While demand for oil in industrialized countries in the 1986–89 period increased about 9%, demand in developing countries increased by about 18% during the same period. In fact the increase in oil demand by developing countries during this period was greater than their overall rate of economic growth. This is due to a number of factors, such as: increasing industrialization in many developing countries; increasing urbanization and higher demand for transportation fuels, limited substitution possibilities because of the high capital requirements for investments in alternative energy sources; and comparatively low domestic prices particularly in oil-exporting countries.[10] In fact demand for oil by developing countries in 1989 slowed only moderately even though they experienced lower rates of economic growth. On the other hand demand for oil continued to increase considerably in the newly industrialized countries (NICs) of the Pacific region.[11] It is unlikely that environmental factors or energy conservation etc will have any significant impact on the growing energy appetites of these countries through the 1990s.

Thus oil will continue to be the world's major energy source, with its share holding steady at about 38% through the 1990s. This is not to say that the world will be using the same amount of oil in absolute terms, however. World oil consumption is projected to rise from its 1989 level of 64.8 mbpd to somewhere between 70 and 73 mbpd by 1995.[12] Oil will remain the largest single energy source in the world, leading its closest competitor (coal) by a wide margin.

This means that at best there will only be a modest amount of interfuel substitution. Although world natural gas consumption has grown strongly over the past 35 years, increasing from 1213.3 million tonnes of oil equivalent (mtoe) in 1978 to 1631 mtoe in 1988,[13] the share of world energy supplied by natural gas is likely to remain constant at about 20%.[14] This is in spite of the fact that gas is the one fossil fuel for which proved reserve estimates have risen significantly – rising from 2520 trillion cubic feet (tcf) in 1978 to 3953 tcf in 1988 (59% in a decade) with most of the increase in the Middle East and Socialist countries.[15] Proved world gas reserves now represent almost as much energy as proved oil reserves – estimated at 102.8 btoe versus 123.8 billion tonnes of oil as of the end of 1988. On the other hand, world gas consumption is only about half as much as oil consumption.[16]

Coal is by far the most abundant fossil fuel, with proved reserves having increased from 884 billion tonnes in 1981 to 1023 billion tonnes in 1988 with most of the increase in the USA, Africa and China, but demand is constrained by high capital costs and environmental concerns. World coal use also increased between 1978 and 1988, from 1860.3 mtoe to 2428 mtoe.[17] Nevertheless, even though unprecedented investments have been made in mining, transportation, and burning coal, its share of world energy consumption is predicted to remain constant, at around 30%.[18] Thus the two fuels often seen as prime candidates for oil substitution are not expected to do better than hold their own in world energy.

Nuclear power is also unlikely to make a major contribution to the energy picture in the foreseeable future. Between 1978 and 1988, nuclear power use grew from 151.6 mtoe to 438.8 mtoe,[19] and during the next several years it will be the fastest growing energy source. Yet even if, as predicted, energy supplied by nuclear power doubles by 2000, it will still provide only 6–7% of world energy use.[20] Little additional capacity is likely to be added once plants now under construction are completed, since high capital costs, low prices for alternative fuels, and safety concerns – heightened by the Three Mile Island and Chernobyl accidents – will discourage increased resort to nuclear power.

Hydroelectric and other renewable energy sources, such as wood fuel, wind, geothermal, biomass, and solar power, supplied 28.7 mbpdoe in 1984 – up from 23.5 mbpdoe in 1973. Installed hydroelectric capacity increased from 405.6 mtoe in 1978 to 537.2 mtoe in 1988. In 1989 total renewable energy sources reached 1803 mtoe,[21] yet in the absence of government support, these sources – except for hydropower and wood fuels – will play relatively insignificant roles in the world energy supply through 2000. Continued research conducted by private industry and the public sector should bring a variety of cost effective technologies into the market after the year 2000. Hydroelectric power, however, which in 1988 provided about 5.5% of world energy, will no more than hold its own at about 5–6% in 2000.[22]

Oil will, therefore, remain the foremost source of world energy well into the twenty-first century, even as it becomes more scarce. Despite recent conservation measures, the rate of oil consumption worldwide still exceeds new discoveries – and is likely to continue to do so. Thus, despite the current oil glut, it is a mistake to write off OPEC, for a number of reasons. OPEC nations still control three-quarters of the world's proved oil reserves,[23] with nearly two-thirds held by Persian Gulf OPEC countries.[24] More importantly, OPEC's dominance of trade in world oil is likely to increase. Though many countries in the world produce oil, most of them consume a great deal of it. The former USSR and the USA, for instance, are the world's two largest oil producers; but of the 12.7 mbpd the USSR produced in 1988, it consumed 8.8 mbpd itself, and although the USA produced 9.7 mbpd in 1988, it had to import 6.7 mbpd to meet its needs. What indicates a nation's impact on the international economy, then, is not simply its crude oil production, but rather its trade in oil. In this connection, it is important to note that even though OPEC's net exports of oil fell from 31 mbpd in 1979 to 19.2 mbpd in 1989, OPEC still accounts for nearly 75% of world oil trade.[25]

Also contributing to OPEC's long-term resurgence is the fact that non-OPEC production peaked in 1987 and has since been on the decline.[26] This represents a break from the 1973–86 trend when total production outside the members of OPEC rose 50%.[27] While this change in large part reflected the absence of major new discoveries similar to those in the North Sea, Alaska, and Mexico in the 1970s, it also resulted from three new developments that are associated, at least in part, with the oil price drop in the 1980s. First has been the decline in output of high-cost areas resulting from reduced exploration and drilling activities, the shutting down of stripper wells, as well as a slowdown in the introduction of enhanced recovery methods. Second, was the voluntary restraint in output and/or exports exercised by several non-OPEC oil exporting countries in support of the efforts by the members of OPEC to bring about a recovery and subsequent stabilization of oil prices. Finally, the tendency for total non-OPEC production to level off in the late 1980s was the result of a natural decline in output from maturing fields in some countries such as the USA and the UK.[28]

Even if output does not then fall precipitously, there will be few, if any, non-OPEC countries or, for that matter, non-Persian Gulf OPEC countries, that will have any export capability by the late-1990s. Alaska's North Slope production, for example, has already begun to fall, contributing to the decline in total US production from 10.545 mbpd in 1985 to 9.7 mbpd in 1988.[29] The exploration and development costs of oil fields in the North Sea are among the highest in the world. Further declines in world oil prices could make a number of North Sea projects uneconomical, and in any case, North Sea production may well have peaked in 1989 when UK output declined as a result of significant supply interruptions caused by accidents and other factors. North Sea production is, therefore, expected to decline steadily in the future. Crude oil production in the USSR, the world's largest producer, also declined in 1989 at an annual rate of about 3% followed by a 6% decline in 1990.[30] While prospects for oil production in the USSR are particularly difficult to assess at the present time, it is generally believed that output will continue to decline. This reflects mainly the depletion of major oil fields and reduced investments in the oil sector – giving rise to the possibility that the USSR will turn from a net oil exporter to a net oil importer by the year 2000.[31] Mexican production is not likely to peak before the mid-1990s, but given the country's rapidly growing domestic needs, it will probably never export much more than the present 1.5 mbpd – in fact, Mexico could become a net importer by the year 2000.[32] Although there has been rising production in some other non-OPEC countries, including Angola, Brazil, China, Colombia, India, Malaysia, Oman, the Syrian Arab Republic, and the Republic of Yemen, which has contributed to the oil glut, the ultimate significance of these new sources is still dwarfed when considered in the context of OPEC's considerable reserves.

Furthermore, because non-OPEC oil reserves are considerably smaller than OPEC's, the current downward spiral in oil prices is causing non-OPEC oil to be depleted much more quickly than new oil discoveries are being made. Thus, ironically, falling oil prices are actually helping to conserve OPEC oil. The depletion of the world's most abundant reserves has slowed, while depletion of some of the scarcest and most strategically important reserves has accelerated. For example, at the 1988 extraction rate, the oil reserves of the USA, the USSR, and the UK will last only 9.5 years, 12.8 years, and 5 years, respectively, while those of Saudi Arabia, Kuwait, Iraq, Iran and the United Arab Emirates will all last over 100 years.[33]

From all indications, then, world oil demand will continue to grow through the 1990s, and OPEC will be the major supplier of that incremental demand, making it the world's 'supplier of last resort'. In other words, oil importers will try to exhaust all other possible sources of oil before turning to OPEC, especially during periods when OPEC oil prices are on the rise. This will tend to amplify the cyclical movements in the demand for OPEC oil. The effects will be double-edged. In times of slowing economic growth and declining demand overall, there will be a more than proportional drop in demand for OPEC oil, since consumers will exhaust other sources of energy, including non-OPEC oil, before they turn to OPEC supply. Likewise, as economic growth increases, raising demand for energy and oil, the demand for OPEC oil will grow more than proportionally, since the supply of non-OPEC oil is relatively fixed. Thus even though, as we have seen, the overall relationship between energy and GNP has been declining, the relationship of OPEC oil to oil-importing nations' GNP will actually be far stronger than in the past. At crucial points, oil-importing nations will be much more vulnerable to OPEC than they were in the 1970s.

OPEC's expansion into downstream operations will be another factor in increasing its control over the world oil market. For example, as OPEC moves farther into the oil industry, adding to its own refining and transportation capacity as well as to its retailing networks, the oil companies will be less and less able to use their current dominance of refineries, transportation, and retail networks to counter OPEC's moves. And because OPEC will be a supplier of both crude oil and an assortment of refined petrochemical products, it will be able to price oil products so as to better achieve its overall pricing strategy. Of course, since not all OPEC members are moving into downstream operations, and since some are moving there faster than others, there will most likely be a certain amount of friction between those that remain primarily exporters of crude and those that increase their vertical integration within the world oil market. The recent damage to Kuwaiti oil facilities is not considered to affect this scenario in any significant way.

In the long run, in fact, not all OPEC nations will fare well. Rather, the market will be dominated by a few key exporters: Saudi Arabia, Iraq, Iran, Kuwait, and the United Arab Emirates, which together have 63% of the world's proven oil reserves. Several other OPEC countries with more limited reserves are already producing at maximum capacity in an effort to generate the funds they need for internal development. In fact the most recent OPEC oil ministers' agreements were reached due to the willingness of some OPEC members to forgo part of their quotas, due to their inability to meet them; they were then transferred to other members. In contrast, Persian Gulf countries with the largest reserves, particularly Saudi Arabia, will undoubtedly resort to restricting production (as on similar occasions in the past) in order to support OPEC prices.

The impact of these current patterns will be strongly felt by the turn of the century, when OPEC exporters outside the Persian Gulf, such as Indonesia, Nigeria, Algeria, Ecuador, and Gabon, whose estimated reserves are one-tenth those of the Persian Gulf countries, will face resource constraints due either to declining oil production capabilities or to increasing domestic demand. As a result, they will export only an inconsequentially small amount of oil – or may be out of the oil export business altogether. The key Persian Gulf oil exporters will then dominate the world oil market. In fact, recent studies conclude that, given current levels of demand and expected additional discoveries of oil, the Persian Gulf states can continue to supply oil to the world into the second half of the twenty-first century.[34]

Finally, when thinking about the world oil market, it is important to remember that the current glut tends to mask OPEC's real power. One must remember that the loss of exports from Iraq and Kuwait was offset primarily by increased production by other OPEC countries, mainly Saudi Arabia. Furthermore OPEC still dominates the international oil market: as recently as 1989, its share of net world exports of oil was 73.8%.[35] All available evidence indicates that this share will increase over time. Thus if any independence from OPEC – specifically, from Middle East oil producers – has developed in the 1980s, it has served only to provide a false sense of security. To the extent that Western industrialized nations have failed to develop alternative energy sources and have rapidly depleted their strategically secure reserves, they have only increased their long-term dependence on OPEC oil. The lower OPEC's current share of the world market, the greater its share will be at the end of the century, when many other countries will be running out of oil. OPEC may then become a more powerful organization – smaller, more geographically concentrated in the Persian Gulf. At the same time, the world's reserves will be more limited than at any time in recent history.

In such a situation, America's position would be even weaker that it was during the 1970s, when OPEC was considered to be at the peak of its power. Since 1985, US demand for oil has grown at 2.63% per year, rising over 1 mbpd.[36] Between 1990 and 2000, US demand for oil will grow by at least 1% per year, rising by 2 mbpd over that period. On the other hand, because of drastically reduced drilling and maturing oil fields, US crude production will fall by 2.5% per year between 1990 and 2000, resulting in a decline of over 2 mbpd.[37] Natural gas output will also fall.[38] Consequently, net oil imports will rise from 6.7 mbpd in 1988 to nearly 12 mbpd in 2000.[39] Just as OPEC's control is strongest, then the USA will become more dependent on imported oil.

Oil – the critical resource

The USA, with a GNP in 1993 approaching $6500 billion, consumes more oil than any other nation in the world – estimated in 1993 at 175 mbpd. This accounts for about one-third of total capitalist-world oil consumption and over one-fourth of total world consumption. The USA also produces a large amount of oil estimated at 9.7 mbpd in 1988 – making it the second largest producer after the USSR. This implies that the USA is the world's largest importer of oil currently estimated at 7.3 mbpd.[40] US imports have steadily risen in recent years after reaching a low of 4.5 mbpd in 1983.[41] This trend is expected to continue with a 1987 US Department of Energy study projecting US imports in the range of 8–10 mbpd in the mid-1990s[42] and reaching 12 mbpd by 2000.[43] This implies a growing reliance on OPEC oil and particularly insecure Persian Gulf oil.

In comparison with other large producers, US oil reserves are very limited, estimated at about 34.6 billion barrels or only 3.8% of proved world oil reserves.[44] At its current rate of production, US reserves will last about nine years; in comparison, Saudi Arabia's reserves–to–production ratio is over 100 years.[45] Furthermore, finding and producing oil is much more expensive in the USA than in most other countries, particularly OPEC countries. Average crude oil production costs in the US are $13–14 a barrel compared to $5–6 a barrel in the Middle East.[46] Despite intensive US drilling, discoveries of new crude oil reserves remain very low. No major oil discovery has been made in the USA since Prudhoe Bay in North Alaska in the early 1970s. Undiscovered oil reserves most likely follow a geographic pattern similar to that of known reserves – and most of the world's proved oil reserves lie in the Persian Gulf region.

A potential source of reserves in the future is through 'enhanced oil recovery' (EOR) which refers to more sophisticated techniques that can remove a larger fraction of the oil from a particular reservoir. While EOR has potential in the 'Lower 48' states, its costs are much too high, and present low oil prices have discouraged R&D in this area by the oil industry. So well explored for oil are the 'Lower 48' that only offshore regions and North Alaska offer any prospects for finding big new US oil fields. Unfortunately, these are the areas where production costs and potential environmental costs are the highest.

What all these trends imply is that we are now witnessing the start of a transition to a more concentrated, and more powerful OPEC – smaller and more geographically concentrated in the Persian Gulf. More importantly, what is evolving is a 'cartel' in the true sense of the word, and one that is not guided by ideology but market forces. That OPEC survived the Persian Gulf war intact is testament to the new pragmatic and business oriented OPEC. Certainly such a regime will have costs to the USA and other oil-importing nations. But the problem is not only limited to high oil prices or (if one regards the situation from an OPEC perspective) low oil prices; it is, rather, the oil market's overall instability. That instability has been severe under the current oil regime, and it could become even more so in the transition period ahead, causing dramatic swings in price that, in the final analysis, will benefit neither producers nor consumers.

The consequences of oil market instability are numerous. For one thing, it creates serious international adjustment problems – disequilibria in capital and trade flows that cannot be managed without government intervention and that can disrupt both national and world economic growth. It can also cause shock effects, which may be either inflationary or deflationary. While rapidly rising oil prices contributed significantly to the cost-push inflation of the 1970s, falling oil prices had the opposite effect in the 1980s. This has caused some economists to worry about the possibility of a new deflationary era analogous to the 1930s.

Furthermore, oil market instability distorts investment, both in energy development and in industry in general. On the one hand, investments in oil production that are made during periods of skyrocketing prices have to be given up as unprofitable when prices fall. On the other hand, dramatic oil price drops tend to postpone those investment decisions needed to secure energy supplies in the future.

Thus America's current complacency over the perceived weakening of OPEC is causing it to neglect what it needs to do to manage its energy needs in the 1990s and beyond. This is especially serious because the current regime of low oil prices is setting the stage for declining oil supplies in the future. First, as suggested above, it has led to a significant decline in world oil industry investment, since new exploration and field development is too expensive to be attractive. If prices remain around current levels, or sink even further, the funds oil companies have for exploration will be billions of dollars a year lower than in earlier years. As a result, companies will be able to undertake fewer projects and production will suffer. According to an American Petroleum Institute survey, US expenditures on oil exploration and production dropped from $75 billion in 1985 to $32 billion in 1991 – a drop of more than one-half. Over the same period, the number of wells drilled decreased by nearly 60%, from 75 000 to 30 000; total US oil production fell by 2.7 mbpd; and there was a loss of some 300 000 jobs – almost 20% of all US petroleum industry jobs.[47]

Furthermore, low oil prices make high-cost oil production, especially offshore oil and enhanced extraction processes, unprofitable. It is difficult to estimate how much world production will become uneconomical if prices remain at or below current levels, since, in the short run, owners of high-cost wells may continue to keep them operating in the hope that prices will recover. Even so, US production in 1988 was nearly 800 000 bpd lower than in 1985,[48] as companies began shutting down high-cost oil wells and thousands of stripper wells (those producing fewer than 10 barrels per day). Once shut in, many of these wells may never be re-opened, even when prices do rise.[49]

Current low oil prices also make certain deposits uneconomical to develop. This would cause already proven and recoverable reserves to be revised downward. Thus US proved reserves – 34.6 billion barrels as of 1988 – are likely to fall over the next several years. America's free-market ideology exacerbates this problem. Because US laws encourage debt rather than equity, it is easier for US oil companies to add to their reserve stocks through corporate takeovers than to use their resources to explore for new deposits. Consequently, the 1980s saw a wave of oil company acquisitions that has reduced the number of independents by more than 25%.

Although there is a consensus that a competitive US oil industry is vital to energy security, it is also agreed that current low oil prices have reduced US oil exploration and production, thus increasing reliance on insecure supplies particularly from the historically unstable Persian Gulf. It is important to understand that it is the global reliance on the Persian Gulf that matters, not just the level of US imports. US oil supplies will be affected during a disruption, even if the USA does not import oil from the disrupted region.

Thus, it is important to try to improve the stability of the Persian Gulf region. Yet if a supply disruption should occur, the USA ought to have the ability to deal with it. According to a recent report to Congress on contingency plans to deal with disruptions in Persian Gulf crude oil supply,[50] the USA has allegedly already taken the necessary measures to strengthen energy security. These measures include, first, the adoption of a flexible market-oriented response policy. To that effect, the USA and some other nations have decontrolled oil prices and dismantled mandatory allocation systems. In any future petroleum disruption, industrial and private consumers will make consumption decisions according to their individual requirements, based on market signals rather than on government regulations. While the price mechanism is the most efficient system for allocating scarce resources, in the case of oil it would only serve to exacerbate the fundamental problem of oil instability, throwing the world energy markets into greater turmoil.

Second, the USA and several other countries in the International Energy Agency (IEA) have established government-owned and controlled strategic oil stocks, which could be drawn down and brought to the marketplace in an emergency. At the end of

February 1991, the US Strategic Petroleum Reserve (SPR) stood at about 585 million barrels – equivalent to about 95 days of total 1987 US net oil imports, with 120 days of net import equivalent being targeted. It is claimed that SPR can be drawn down at an average rate of 3 mbpd for the first 120 days and at reduced rates thereafter. While SPR represents a significant buffer against the effects of an oil supply disruption and a significant improvement over strategic stock levels during previous disruptions, it must be borne in mind that this is only a short-run stop-gap measure. What then? Furthermore, how would the USA ration oil from SPR without circumventing its market oriented response policy? To what extent is 585 million barrels of oil in those underground reserves fully recoverable? What proportion will depend on expensive EOS technology, thus placing it in the same category as other EOS-dependent US oil reserves?

The third measure designed to deal with a supply disruption is the establishment of a coordinated international response procedure by IEA countries – such as coordinated drawdown of stocks or petroleum sharing. Given the interrelated nature of today's world oil market, a synchronized response by IEA countries will bring about more benefits than if each country acted separately. Yet this is easier said than done and even if IEA countries abide by these procedures, it must be remembered that non-IEA countries' share of world oil imports is steadily rising but, more importantly, cooperation by IEA countries does not physically affect the flow of oil in world markets.

Finally, the USA will encourage a flexible energy system which will encourage a fuel switching capability such as waiving certain legislative restrictions, ie Clean Air Act emission standards, and implementing emergency energy conservation in Federal facilities as provided by the Federal Energy Management Program. Yet again these are either short-term measures or carry substantial environmental costs.

Ignoring for the moment that these measures do not even address the basic problem of oil price instability and dwindling energy reserves, they do not in themselves reduce reliance on insecure oil supplies either, but merely bolster the ability to respond to temporary disruptions once they have occurred, such as those that arose following Iraq's invasion of Kuwait.

In another recent study by the US Department of Energy,[51] a more direct method of coping with insecure oil supplies is suggested – to actually reduce dependence on Persian Gulf oil. Three ways of doing this are enumerated. First, increasing oil production in more secure world regions such as the USA, Canada, Norway, the UK, Mexico, Venezuela, and other countries outside the Persian Gulf. Second, increasing energy efficiency. Third, increasing production of oil substitutes like natural gas, coal, nuclear and renewable energy.

While this longer-range, three-pronged approach is what is needed, what is missing is an overall national energy plan that would achieve these objectives. Maintaining a steady energy supply cannot be left to the private sector alone, since the time frame required to take the necessary actions is beyond the private sector's quarter-to-quarter profit-and-loss planning mentality.

Policy options that involve government incentives to promote US oil exploration and production include oil import fees and/or price floors, tax and financial incentives, and lease terms and royalty fees. All three options may reduce the costs of exploration, and/or they may increase the revenues firms can expect from producing new reserves. Yet they all have large economic costs for consumers, the oil industry, the environment, the Federal budget deficits, the macroeconomy, and the balance of trade deficits. While these various competing objectives must be balanced against one another in evaluating policy options, neither the Reagan Administration's energy policy nor the Bush Administration's energy policy offered a context for achieving such a balance. This is because the basic strategy for achieving the Reagan and Bush Administrations' policy objectives was reliance on the free market system to the exclusion of any government involvement. While the market system is the most important ingredient of any national energy policy, the Reagan and Bush Administrations' energy policy was characterized by the very absence of direction or leadership since their 'hands-off' ideology has led to inaction and total lack of national vision. As a result, the USA is no more energy secure in 1993 than it was in 1973.

In response to those who would believe that the US reaction to the Iraqi invasion of Kuwait constitutes a national energy policy, one must bear in mind that oil supplies were not interrupted in any meaningful way as there was enough excess capacity to offset the cutoff of supplies from Iraq and Kuwait. During the next crisis Saudi Arabia may not be in a position to increase output by 3 mbpd. Furthermore, is it a viable national energy policy to have to maintain access to oil supplies through the exercise of military force or the threat of such force? It would appear that there are far less costly and certainly less violent methods of guaranteeing our energy future than having to resort to war every time the flow of oil is disrupted.

Energy efficiency – conservation

Between 1973 and 1985, US energy intensity declined 23%. However, there is much room for improvement. In 1986, the USA used 10% of its GNP on energy, by comparison, Japan used only 4%.[52] Today, the USA uses virtually no more energy than it did in 1973. Higher energy prices have stimulated the use and development of energy technologies that are more efficient. This has taken place primarily through market forces. Therefore, we can expect a decline in the pace of improvements in average energy efficiency with the recent declines in world oil prices. Fortunately, most of the improvements that have already taken place involve long-term or permanent changes to capital stock, ie more fuel efficient autombiles, better insulated houses, and more efficient industrial processes. Others, however, represent behavioural changes, ie more timely maintenance of industrial equipment and different habits in thermostat settings – changes that are more closely correlated to current world oil prices.

The 23% increase in energy efficiency in the USA between 1973 and 1985 is the avoided equivalent of 14 mbpd of crude oil. This is the most important development in the field of energy since the first oil price shock of 1973 – contributing more to US energy security than any other factor. Given the high cost of oil exploration and production, it is now taken for granted, as stated in a 1987 report of the IEA that, 'Investment in energy conservation at the margin provides a better return than investment in energy supply'.[53] But energy efficiency, while making economic sense, can save more than fossil fuels. It can reduce growing dependence on the Persian Gulf which is becoming an increasingly explosive military tinderbox. The total amount of military hardware in the region now exceeds the already high levels that existed prior to the Persian Gulf War. Energy efficiency can also reduce acid rain which is devastating forests in Europe and North America. It can also help stem the rise of CO_2 levels and help ameliorate the greenhouse effect on the world's climate.

Over the past 15 years, industry and the private sector in most countries, particularly in the USA, has led the way in improving energy efficiency. Yet the pace of this improvement has slowed down in recent years with the decline in oil prices. What is needed is a doubling of the national effort to increase investment in energy efficiency which will simultaneously lead to lower oil dependence, reduced air pollution, and climate protection. But this implies a growing partnership between the private and public sectors, with the latter setting the goals and the direction, providing seed money for R&D, and possibly raising efficiency standards, yet allowing the markets to decide how best to achieve these goals. At present, the USA is not energy secure. If it can increase its energy efficiency by another 23% by the year 2000, it might make the most important contribution to US energy security at the lowest cost while at the same time safeguarding our environment.

Fossil fuel substitution – renewables

While technological progress since 1973 has resulted in significant improvements in energy efficiency levels worldwide, it is unlikely that the pace of this progress can continue given the low level of oil prices since 1986. Furthermore, while investment in energy efficiency is more productive than investment in fossil fuel supplies, our ultimate dependence on limited fossil fuels, particularly oil, remains. In order to break this ultimate constraint and thus guarantee US and world energy security, we need to shift to energy sources that are essentially inexhaustible. This includes many diverse sources such as a solar, wind, geothermal, hydro, and biomass that are commonly lumped together under the term 'renewable energy'. Of these, only hydroelectric power and biomass are in widespread use throughout the world today. Together they provide about 21% of the energy consumed worldwide, of which 6% is hydropower and 15% is biomass – primarily firewood.[54]

In the USA, these renewables provide about 9% of the energy consumed, of which 5% is hydropower and 4% is firewood.[55] Most US rivers with the highest hydroelectric potential are already being exploited. Consequently, in the USA, which has the largest installed hydroelectric capacity in the world, not a single new large dam has been approved to receive federal funding since 1976. Thus, any new large supplies of hydroelectric power in the USA are likely to be imported from Canada.[56]

Wood and agricultural waste are the second most important form of renewable energy in use in the USA today. However, use of wood and agricultural wastes for energy purposes is expected to grow only slightly over the next decade – largely because of the availability of low priced commercial fuels such as oil, gas, and electricity.

Energy derived from solar, geothermal, wind, and biomass (other than firewood and agricultural waste) plays a relatively small role today compared to the principal commercial energy resources. Yet these renewables represent an extremely large resource base that, over the long term, could become a major new source of energy supply. The rate of technological progress and future prices for depletable resources will ultimately determine when one or more of these renewable resources will become economically competitive. One of the advantages of these renewables in the long run is that they are based on technology – rather than on insecure, environmentally hazardous, and limited fossil fuels. Therefore, by definition, renewable energy can significantly increase US energy security. Unfortunately, given the high start-up costs, current low oil prices, and other deterrents to long-term investment, it is unlikely that renewable energy will play any significant role in US energy security between now and 2010.

Renewable energy technologies do provide technological optimism for US energy security in the distant future. Yet in order to hasten the emergence of renewable energy a strategy that includes an increased government leadership role, an increase in research, and active international energy collaboration is needed. The main danger is that such a strategy might evolve too slowly, overtaken by environmental problems and the social and economic upheavals that could accompany them. The USA and the rest of the world has only a limited time to map a strategy for a sustainable energy future. Without such a comprehensive energy strategy that would bridge the limited fossil fuel supplies of the present with the alternative energy sources of the future, the USA will find itself less secure, facing a colder and darker twenty-first century.

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[1] *BP Statistical Review of World Energy: 1989*, London, UK, June 1989, p 2.

[2] *World Economic Outlook: 1990*, International Monetary Fund, Washington, DC, October 1990, p 25.

[3] *Wall Street Journal*, 1–7 November 1990. This represents an average petroleum spot price which is the simple average spot market price of Brent, Dubai, and Alaskan North Slope, representing light, medium and heavy crude oils in three different regions of the world.

[4] *Washington Post*, 2 November 1990, p F1.

[5] *Wall Street Journal*, 30–31 May 1991.

[6] For an in depth analysis of the underlying trends in the world oil market, see: George C. Georgiou, 'Oil market instability and a new OPEC', *World Policy Journal*, Spring, 1987, pp 295–312.

[7] *Energy Security: A Report to the President of the United States*, United States Department of Energy, Washington, DC, March 1987, p 20.

[8] *World Economic Outlook: 1990*, International Monetary Fund, Washington, DC, May 1990, pp 95–96.

[9] *World Energy Outlook Through 2000*, CONOCO, Wilmington, DE, September 1986; *World Economic Outlook: 1990*, *op cit*, Ref 8, p 95, and *World Economic Outlook: 1991*, *op cit*, Ref 2, p 84.

[10] *World Economic Outlook: 1990*, *op cit*, Ref 8, pp 96–97.

[11] BP, *op cit*, Ref 1, pp 9–10.

[12] Projected growth assuming a 1.5–2.0% annual rate during this period.

[13] BP, *op cit*, Ref 1, p 20.

[14] *World Energy Outlook Through 2000*, op cit, Ref 9; *Energy Security*, *op cit*, Ref 7, pp 38–39; and BP, *op cit*, Ref 1, p 34.

[15] BP, *op cit*, Ref 1, p 20.

[16] *Energy Security*, *op cit*, Ref 7, pp 38–39; and BP *op cit*, Ref 1, p34.

[17] *Ibid*, p 24.

[18] *Energy Security*, *op cit*, Ref 7, p 38, and BP, *ibid*, p 34.

[19] Energy Security, *op cit*, Ref 7, 44; *op cit*, Ref 1, p 28.

[20] Christopher Flavin, *World Oil: Coping with the Dangers of Success*, Worldwatch Paper 66, Washington, DC, USA, July, 1985, p 41; and *op cit*, Ref 1.

[21] *State of the World: 1991*, Worldwatch Institute, Washington, DC, USA, 1991, p 25.

[22] *Op cit*, Ref 7, pp 38, 45; and *BP Statistical Review of World Energy: 1986 and 1989*, pp 30, 34.

[23] *Op cit*, Ref 9; *op cit*, Ref 7, p 18; *op cit*, Ref 1, p 2.

[24] *United States Geological Survey: 1983*; and *op cit*, Ref 9, p 18.

[25] *World Economic Outlook: 1985 and 1990*; and *op cit*, Ref 1, p 19.

[26] *Op cit*, Ref 1.

[27] *Op cit*, Ref 8, p 95.

[28] *World Economic Outlook: 1988*, pp 98–99.

[29] *Op cit*, Ref 1, p 5.

[30] *World Economic Outlook: 1991*, International Monetary Fund Washington, DC, May 1991, p 81.

[31] *Op cit*, Ref 8, pp 97–98.

[32] *Op cit*, Ref 20, p 29.

[33] *Op cit*, Ref 1, p 2.

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[35] *Op cit*, Ref 8, p 95.

[36] *Op cit*, Ref 1, pp 9–10.

[37] *Ibid*, pp 4–5, 9–10.

[38] *Op cit*, Ref 9.

[39] *Two Energy Futures: National Choices Today for the 1990s*, American Petroleum Institute, Washington, DC, July 1986, p 28; and *op cit*, Ref 1, pp 4–5, 9–10.

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[41] *Op cit*, Ref 39, p 28; and *op cit*, Ref 1, pp 4–10.

[42] *Op cit*, Ref 7, p 25.

[43] *Op cit*, Ref 39, p 28.

[44] *Op cit*, Ref 7, p 50; and *op cit*, Ref 1, p 2.

[45] *Op cit*, Ref 1, p 2. Similarly, Iran, Iraq, Kuwait and the United Arab Emirates all have R/P ratios in excess of 100 years.

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[47] *Op cit*, Ref 39, pp 11–12.

[48] *Op cit*, Ref 1, pp 4–5.

[49] *Op cit*, Ref 39, p 11.

[50] *Op cit*, Ref 40, pp i–viii.

[51] *Op cit*, Ref 7.

[52] *State of the World: 1988*, Worldwatch Institute, W.W. Norton and Co, New York, 1988, pp 42–43.

[53] *Ibid*, p 41.

[54] *Ibid*, p 62.

[55] *The National Energy Plan*, United States Department of Energy, Washington, DC, 1985, p 26.

[56] *Op cit*, Ref 52, p 64.